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EXAMINER	
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Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No.	Applicant(s)	
	10/824,288	SHTEIN ET AL.	
	Examiner	Art Unit	
	Matthew W. Such	2891	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *11 May 2007*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-34* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-34* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

Claim Rejections - 35 USC § 112

1. The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

2. Claims 1, 17 and 33-34 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. The term "bulk heterojunction" in claims 1, 17 and 33-34 is a relative term which renders the claim indefinite. The term "bulk heterojunction" is not defined by the claim, the specification does not provide a standard for ascertaining the requisite degree, and one of ordinary skill in the art would not be reasonably apprised of the scope of the invention. The term "bulk heterojunction", as best can be determined from the specification, is an "intricate interpenetrating network with a large interfacial area between the two phases" (Para. 0029; Figs. 1b, 3a, 3b, 3c). However, the term "bulk heterojunction" as defined by the specification *fails to define the degree to which interpenetration of the two phases occurs.* Therefore, *any* amount of interpenetration between the two phases, even at the atomic scale, meets the term "bulk heterojunction". The specification also describes a "bulk heterojunction" as "having a sufficiently high surface area-to-volume ratio to form a bulk heterojunction" (Para. 0038, 0041-0042), but does not define the degree to which the surface area-to-volume ratio is "sufficiently high". Therefore, any surface area-to-volume ratio, meets the term "bulk heterojunction". The specification also describes a "bulk heterojunction" as "protrusions"

(Abstract; Para. 0042), but does not define the degree to which the surface protrudes. Therefore, *any* amount of protrusion in the first layer, even at the atomic scale, meets the term "bulk heterojunction".

3. Claims 1, 6, 9, 17, 20-21, 24 and 31-34 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. The term "small molecule" is a relative term which renders the claim indefinite. The term "small molecule" is not defined by the claim, the specification does not provide a standard for ascertaining the requisite degree, and one of ordinary skill in the art would not be reasonably apprised of the scope of the invention. Therefore, any molecule can be considered a "small molecule".

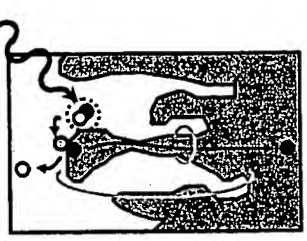
4. Claims 1, 17 and 33-34 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. The term "surface area-to-volume ratio" is not defined by the claim, the specification does not provide a standard for ascertaining the requisite degree, and one of ordinary skill in the art would not be reasonably apprised of the scope of the invention. While the specification clearly defines the "surface area" portion of the ratio to be "only the surface area of the deposited first layer which will be in contact with the second layer deposited thereon (i.e., the interface of the first and second layers)" the specification does not define what constitutes the "volume" portion of the term. It is, therefore, unclear as to what volume of the first layer is included in determining the "surface area-to-volume ratio", such as the entire

amount of space in three dimensions of the entire first layer or the portion of the amount of space in three dimensions of the first layer which is interpenetrated. Furthermore, if the term "volume" refers to the amount of space in three dimensions of the first layer which is interpenetrated, it is further unclear where the boundary is defined distinguishing the amount of space in three dimensions of the first layer which is considered the "volume" from the amount of space in three dimension of the first layer which is not considered as the "volume".

5. Claims 9 and 24 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. The claim requires that "the cohesive energy of the first organic small molecule is such that the first organic small molecule material tends to adhere to itself rather than the underlying substrate", without defining the degree to which the adherence occurs. All layers have some degree to which they tend to adhere to, simply to exist as a layer, otherwise the layer would simply not exist. Therefore, any layer of a first organic small molecule must have "the cohesive energy of the first organic small molecule is such that the first organic small molecule material tends to adhere to itself rather than the underlying substrate" if it exists. Furthermore, the claim merely states that the material only "tends" to adhere to itself and does not actually require any degree for this tendency to actually occur.

6. Claims 20 and 21 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. The claim recites the limitation "the diameter of the protrusions", but

does not define what constitutes "the diameter" and one of ordinary skill in the art would not be reasonably apprised of the scope of the invention. For example, the diameter can the a circumference around the protrusion by, for example (see gray lines as examples of "diameters"):

1 (b)  , or any other arbitrary definition.

Claim Rejections - 35 USC § 102

7. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (a) the invention was known or used by others in this country, or patented or described in a printed publication in this or a foreign country, before the invention thereof by the applicant for a patent.
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.
>
> (e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

8. In so far as definite, claims 1-3, 9-10, 14, 17-19, 24-25, 29 and 33-34 are rejected under 35 U.S.C. 102(a) as being anticipated by Ishikawa (Appl. Phys. Lett.).

a. Regarding claims 1, 10, 17, 25 and 33-34, Ishikawa teaches a method of producing a optoelectronic device by depositing a first layer (electron donor or electron

acceptor) over a first electrode (anode or cathode) by an organic vapor phase deposition method (Page 2424, Right Col.). The manner in which the claim is written does not define what a "small molecule" includes and therefore be any organic molecule can be a "small molecule" by arbitrary definition. A second layer (electron acceptor or electron donor) is deposited on the first layer such that the first layer is in contact with the second layer and the interface forms a "bulk heterojunction" (Page 2424, Right Col.). The manner in which the claim is written does not define the degree of characteristics that distinguish a heterojunction as a "bulk heterojunction" and therefore the "bulk heterojunction" of Ishikawa meets the claim limitation. The entire device is formed over a substrate (Fig. 1, for example).

b. Regarding claims 2-3 and 18-19, Ishikawa teaches that the first layer can be an electron donor layer, the first electrode can be an anode, the second layer can be an electron acceptor layer and the second electrode can be a cathode (Page 242, Right Col.). The Examiner notes that the device can be turned upside down and the Elements inverted since the terms "first layer" and "second layer" are completely arbitrary (for example, the first electrode can be a second electrode by arbitrary definition).

c. Regarding claims 9 and 24, the manner in which the claim is written does not distinguish the invention from the prior art since the first organic molecule has some tendency to adhere to itself or the layer could not exist.

d. Regarding claims 14 and 29, Ishikawa teafches that a "wetting layer" is deposited over the first electrode (for example PEDOT over ITO; Page 2425, Left Col.) such that the first layer is deposited over the wetting layer. A planarizing layer (for example LiF over the second layer; Page 2425, Left Col.) such that the second electrode is deposited over the planarizing layer.

9. In so far as definite, claims 1-3, 9-11, 17-19, 24-26 and 33-34 are rejected under 35 U.S.C. 102(b) as being anticipated by Han (`665).

a. Regarding claims 1, 17, 33 and 34 Han teaches a method for forming optoelectronic devices wherein a first layer (Element 4) over a first electrode (Element 7) by an organic vapor phase deposition (see Para. 0044 for vapor deposition of organic semiconductor). The first layer comprises a first organic small molecule material, such as phthalocyanine (Para. 0023, 0033, etc.). A second layer (Element 3) is deposited on the first layer such that the first and second layers are in physical contact (see the contact line at Element 4). The interface provides a "bulk heterojunction" since it has some protrusions (as shown in, for example, Fig. 1). A second electrode (Element 2) is deposited over the second layer. The Examiner notes that the device can be turned upside down and the Elements inverted since the terms "first layer" and "second layer" are completely arbitrary (for example, Element 2 can be a first electrode and Element 7 can be a second electrode).

b. Regarding claims 2-3 and 18-19, Han further teaches that the first layer can be an electron donor layer, the first electrode can be an anode, the second layer can be an electron acceptor layer and the second electrode can be a cathode (Para. 0036-0042). The Examiner notes that the device can be turned upside down and the Elements inverted since the terms "first layer" and "second layer" are completely arbitrary (for example, Element 2 can be a first electrode and Elements 6 and 7 can be a second electrode).

c. Regarding claims 9 and 24, the manner in which the claim is written does not distinguish the invention from the prior art since the first organic molecule has some tendency to adhere to itself or the layer could not exist.

d. Regarding claims 10-11 and 25-26, Han further teaches that the first layer can be over a substrate (Element 1 or 8), which can be plastic (Para. 0019).

10. In so far as definite, claims 1-5, 9-11, 17-21, 24-26 and 33-34 are rejected under 35 U.S.C. 102(b) as being anticipated by Saurer (`570).

a. Regarding claims 1, 17 and 33-34, Saurer teaches a method of fabricating an optoelectronic device by depositing a first layer with protrusions (Element 14, for example) over a first electrode (Element 6, for example) by organic vapor phase deposition (Col. 4, Lines 12-14 and 35-41, for example). The first layer comprises a first organic small molecule (Col. 6, Lines 33-57). The manner in which the claim is written

does not define what a "small molecule" includes and therefore be any organic molecule can be a "small molecule" by arbitrary definition. A second layer (Element 16, for example) is deposited on a first layer such that the second layer is in physical contact with the first layer and the interface of the second layer and the first layer forms a "bulk heterojunction" (see Figs. 2-5, for example). The manner in which the claim is written does not define the degree of characteristics that distinguish a heterojunction as a "bulk heterojunction" and therefore the interpenetrated network of Saurer meets the claim limitation. A second electrode (Element 10, for example) is deposited over the second layer to form an optoelectronic device. The entire device is formed over a substrate (Element 2, for example).

b. Regarding claims 2-3 and 18-19, Saurer teaches that the first electrode can be either an anode or cathode, the first layer can be either an electron acceptor or donor layer and the second electrode can be either a cathode or anode (vice versa from the first electrode) and the second layer can be either an electron donor or acceptor (vice versa from the first layer; Col. 6, Lines 34-57, for example).

c. Regarding claims 4 and 5, since neither the claim nor the specification defines what "volume" is required for the surface area-to-volume ratio, the volume value can be arbitrarily chosen to meet the claim since the roughness factor of the actual surface area of the first layer compared with the cross-sectional surface area is, for example, 100 (Col. 4, Lines 35-41).

d. Regarding claims 9 and 24, all layers have some degree to which they tend to adhere to itself, in order for the layer to exist. The first layer comprising the first organic small molecule material exists (see Element 14, for example). Therefore, any layer of a first organic small molecule must have "the cohesive energy of the first organic small molecule is such that the first organic small molecule material tends to adhere to itself rather than the underlying substrate" since it exists.

e. Regarding claims 10-11 and 25-26, Saurer teaches that the first layer is deposited over a plastic substrate (Element 2; Col. 4, Lines 9-11; see Figs. 2-5, for example).

11. In so far as definite, claims 1-5, 9-11, 17-19, 23-26 and 33-34 are rejected under 35 U.S.C. 102(e) as being anticipated by Foust (`508).

a. Regarding claims 1-2, 9-11, 17-18, 23-26, and 33-34, Foust teaches a method for producing and optoelectronic device by depositing organic layers on a plastic substrate (Paragraphs 0016-0018) with an indium-tin-oxide (ITO) electrode (Paragraph 0024) by an organic vapor phase deposition (OVPD) method (Paragraphs 0007 and 0034). Organic compounds and other layers have some roughness wherein a first layer tends to adhere to itself, even at the atomic scale, inherently forming protrusions since Foust teaches the method as disclosed in the claims 1 and 17.

Foust teaches that an electron donor layer of copper phthalocyanine (CuPc) is deposited on ITO (Paragraph 0028). The CuPc layer adheres to itself as well the electrode on which it is deposited, rather than the substrate, since the electrode covers the substrate. An electron acceptor layer of buckminsterfullerene (C60) is deposited directly on CuPc (Paragraph 0029) and a second electrode is formed over the structure (Paragraphs 0030-0031 and 0035).

b. Regarding claims 3 and 19, Foust teaches the device may be deposited in reverse since the ITO electrode can form the cathode (Paragraph 0026).

c. Regarding claims 4 and 5, Foust teaches that the surface area to volume ratio of the first layer is at least 5:1. The surface area to volume ratio is defined by:

$$Ratio = \frac{Area}{Volume},$$

and the surface area is interface between the first and second layers. Foust shows that metal grids (Element 22) are 1 inch by 1 inch squares or 65,460,000 square microns. Since neither the claim nor the specification defines what "volume" is required for the surface area-to-volume ratio, the volume value can be arbitrarily chosen. For example, the thickness of the entire first layer can be used to calculate "volume" along with the surface area. Since the thickness on the first layer is, for example, 500 Angstroms or 0.05 microns (Para. 0026), then the surface area to volume ratio is geometrically required to be several orders of magnitude higher than 5:1, such as 20:1.

Claim Rejections - 35 USC § 103

12. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

13. Claims 4 and 5 are rejected under 35 U.S.C. 103(a) as being unpatentable over Han ('665) who teaches of first layer thickness of, for example, about 0.01 microns (Para. 0036). The surface area to volume ratio is defined by:

$$Ratio = \frac{Area}{Volume},$$

and the surface area is the interface between the first and second layer. Han teaches a thickness for a first layer that is about, for example, 0.01 microns, which leaves only the surface area on the interface as undefined.

However, one would be motivated to set the top and bottom surface area to be as large as possible, such as on the order of meters, in order to produce a large area for incident light. Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to set the surface area to volume ratio to be greater than 5:1 in microns since in order to produce economic quantities of current the area for incident light of a photoelectric conversion device is preferably on any size that is beyond the scale of microns. It has been held that where

the general conditions of a claim are disclosed in prior art, discovering the optimum or working ranges involves only routine skill in the art. *In re Aller*, 105 USPQ 233.

14. In so far as definite, claims 20 and 21 are rejected under 35 U.S.C. 103(a) as being unpatentable over Saurer (`570).

Saurer teaches that a "diameter" of the protrusions are preferably less than the exciton diffusion layer of the first small organic molecule, which would be a less than 1 times the excition diffusion length (Col. 5, Lines 22-39). This ratio allows for a more efficient energy conversion within the device. It would have been obvious to one of ordinary skill in the art at the time the invention was made to set the diameter of the protrusions to be, for example, 1.5 times the excitation diffusion length in order to produce a less efficiently operating device.

15. Claims 12-13, 22, 27-28 and 31-32 are rejected under 35 U.S.C. 103(a) as being unpatentable over Saurer (`570) in view of Forrest (`846).

a. Regarding claims 12-13 and 27-28, Saurer teaches the methods of claims 2 and 18 where the optoelectronic device formed by first and second organic semiconductor layers functions as, for example, a photovoltaic device (Abstract). Saurer does not teach methods for enhancing the efficiency of the device, such as depositing an exciton layer of BCP between the second layer and second electrode.

Forrest teaches depositing an exciton blocking layer of BCP material between the second layer and the second electrode (Forrest Paragraphs 0022-0030). It would have

been obvious to one of ordinary skill in the art at the time the invention was made to add a BCP exciton blocking layer taught by Forrest to the methods taught by Saurer in order to increase the photocurrent density of the photovoltaic device and improve efficiency (Forrest Paragraphs 0026-0030, 0051-0052 and 0062-0067; Figs. 1-2 and 5).

b. Regarding claim 22, Saurer teaches the method of claim 17 where the first electrode is ITO (Col. 3, Line 34), the first organic layer is CuPc (Col. 6, Line 51) and the second organic electron accepting layer can be, for example, perylenes (Col. 6, Line 43). However, Saurer does not teach using the specific compound 3,4,9,10-perylenetetracarboxylic bis-benzimidazole (PTCBI) as an electron acceptor layer, the second organic layer.

Forrest ('846) teaches forming layers of CuPc and either perylene or PTCBI as an electron donor and electron acceptor layer, respectively (Paragraphs 0034, 0044-0045 and 0062-0065). It would have been obvious to one of ordinary skill in the art at the time the invention was made to use PTCBI in place of perylene for an electron acceptor layer since the compounds are functional equivalents (Forrest Para. 0044). It has been held to be within the general skill of a worker in the art to select a known material on the basis of its suitability for the intended use as a matter of obvious design choice. The selection of a known material based on its suitability for its intended use supported a prima facie obviousness determination in *Sinclair & Carroll Co. v. Interchemical Corp.*, 325 U.S. 327, 65 USPQ 297 (1945) See also *In re Leshin*, 227 F.2d 197, 125 USPQ 416 (CCPA 1960). MPEP § 2144.07.

c. Regarding claims 31 and 32, Saurer teaches the methods of claims 1 and 17 where the optoelectronic device formed by first and second organic semiconductor layers functions as a photovoltaic device (Figures). Saurer does not teach other methods for enhancing the efficiency of the device.

Forrest teaches depositing a gold layer as an electron-hole recombination site over a second organic layer, such as PTCBI (Forrest Paragraphs 0062-0065; Fig. 1 and 2). This deposition is followed by a third and fourth layer between over the gold recombination zone and an electrode over the entire structure (Forrest Paragraphs 0023, 0062-0065; Fig. 1 and 2). It would have been obvious to one of ordinary skill in the art at the time the invention was made to add a gold electron-hole recombination layer and a third and fourth organic semiconductor layer over the second organic semiconductor as taught by Forrest to the methods taught by Foust. One would have been motivated to do so to increase the efficiency of the photovoltaic device by boosting photo voltage (Forrest Paragraphs 0023-0024 & 0063; Fig. 3). One would have been further motivated to produce a "bulk heterojunction" between the third and fourth layers in order to increase the light conversion efficiency (Saurer Col. 2, Lines 24032, for example).

16. Claims 14-16 and 29-30 are rejected under 35 U.S.C. 103(a) as being unpatentable over Saurer (`570) in view of Forrest (`846) in view of Foust (`508).

Saurer teaches the methods of claims 1 and 17 wherein CuPc material can be used as an organic semiconductor material in the device which can be deposited by an organic vapor phase

deposition method. However, Saurer does not teach using a PEDOT/PSS layer in tandem with the CuPc layer to form a device.

Forrest teaches using PEDOT/PSS layers on electrodes in order to planarize the surface and prevent shorting instances in the devices (Forrest Paragraph 0057). Although, Foust does not teach using a PEDOT/PSS layer as a planarization over the second organic semiconductor layer below the second electrode, Foust does teach minimization of shorting is desirable. Foust teaches methods where the devices are segmented into discrete elements in order to prevent short circuits in one area of the device from shorting the entire layer set (Foust Paragraph 0035). Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to add a PEDOT/PSS layer as a planarizing layer over the ITO layer and under the second electrode in order to planarized the electrode surfaces and reduce instance of shorting in the devices.

17. Claims 6-8 are rejected under 35 U.S.C. 103(a) as being unpatentable over Foust (`508) in view of Forrest (`102).

Foust teaches the method of claim 1 wherein organic semiconductor molecules can be deposited by OVPD at low temperatures and pressures but does not teach specific conventional details such as the substrate temperature and chamber pressure (Foust Paragraph 0034). Foust teaches that an electron donor layer of copper phthalocyanine (CuPc) is deposited on ITO (Paragraph 0028). The CuPc layer adheres to itself as well the electrode on which it is deposited, rather than the substrate, since the electrode covers the substrate. An electron acceptor layer of

buckminsterfullerene (C60) is deposited directly on CuPc (Paragraph 0029) and a second electrode is formed over the structure (Paragraphs 0030-0031 and 0035).

Forrest teaches OVPD method for depositing organic semiconductor molecules into layers. It would have been obvious to one of ordinary skill in the art at the time the invention was made to deposit the organic layers of Foust by using a substrate temperature of 15 degrees Celsius and a pressure of 0.65 Torr as taught by Forrest in order to maintain surface integrity and quality of the layers (Forrest Col. 8, Lines 5-51). Furthermore, Foust teaches that it is desirable to maintain low processing temperatures during construction of the organic devices to maintain the integrity of the organic layers (Foust Paragraph 0038). It has been held that discovering an optimum value of a result effective variable involves only routine skill in the art. *In re Boesch*, 617 F.2d 272, 205 USPQ 215 (CCPA 1980).

18. Claims 12-16, 22 and 27-32 are rejected under 35 U.S.C. 103(a) as being unpatentable over Foust (`508) in view of Forrest (`846).

a. Regarding claims 12-13 and 27-28, Foust teaches the methods of claims 2 and 18 where the optoelectronic device formed by first and second organic semiconductor layers functions as a photovoltaic or light emitting device (Foust Paragraphs 0005-0007). Foust teaches using a reflective top electrode material to reflect light either generated from the active region or capture additional light from an external source, increasing the efficiency of the device (Foust Paragraphs 0005-0008 and 0035). Furthermore, Foust teaches the use of phosphor particles in the device to convert sunlight wavelengths to wavelength

which are more readily adsorbed by the organic active layers as well as to enhance light trapping (Foust Paragraph 0022). Foust does not teach additional alternative methods for enhancing the efficiency of the device.

Forrest teaches depositing an exciton blocking layer of BCP material between the second layer and the second electrode (Forrest Paragraphs 0022-0030). It would have been obvious to one of ordinary skill in the art at the time the invention was made to add a BCP exciton blocking layer taught by Forrest to the methods taught by Foust in order to increase the photocurrent density of the photovoltaic device and improve efficiency (Forrest Paragraphs 0026-0030, 0051-0052 and 0062-0067; Figs. 1-2 and 5).

b. Regarding claims 14-16 and 29-30, Foust teaches the methods of claims 1 and 17 wherein PEDOT/PSS material can be used as an organic semiconductor material in the device which can be deposited by OVPD (Foust Paragraphs 0027 and 0034). However, Foust does not teach using the PEDOT/PSS layer in tandem with the CuPc and C60 layers to form a device.

Forrest teaches using PEDOT/PSS layers on the ITO electrode in order to planarize the surface and prevent shorting instances in the devices (Forrest Paragraph 0057). Although, Foust does not teach using a PEDOT/PSS layer as a planarization over the second organic semiconductor layer below the second electrode, Foust does teach minimization of shorting is desirable. Foust teaches methods where the devices are segmented into discrete elements in order to prevent short circuits in one area of the device from shorting the entire layer set (Foust Paragraph 0035). Therefore, it would

have been obvious to one of ordinary skill in the art at the time the invention was made to add a PEDOT/PSS layer as a planarizing layer over the ITO layer and under the second electrode in order to planarized the electrode surfaces and reduce instance of shorting in the devices.

c. Regarding claim 22, Foust teaches the method of claim 17 where first and second organic semiconductor layers of CuPc and C60, respectively, are formed to produce an optoelectronic device (Foust Paragraphs 0028-0029). Foust does not teach using the specific compound 3,4,9,10-perylenetetracarboxylic bis-benzimidazole (PTCBI) as an electron acceptor layer.

Forrest ('846) also teaches forming layers of CuPc and C60, or in the alternative CuPc and PTCBI, as an electron donor and electron acceptor layer, respectively (Paragraphs 0034, 0044-0045 and 0062-0065). It would have been obvious to one of ordinary skill in the art at the time the invention was made to use PTCBI in place of C60 for an electron acceptor layer since the compounds are functional equivalents. It has been held that the selection of a known material based on its suitability for its intended use supported a prima facie obviousness determination in *Sinclair & Carroll Co. v. Interchemical Corp.*, 325 U.S. 327, 65 USPQ 297 (1945) See also *In re Leshin*, 227 F.2d 197, 125 USPQ 416 (CCPA 1960). MPEP § 2144.07.

d. Regarding claims 31 and 32, Foust teaches the methods of claims 1 and 17 where the optoelectronic device formed by first and second organic semiconductor layers

functions as a photovoltaic or light emitting device (Foust Paragraphs 0005-0007). Foust teaches using a reflective top electrode material to reflect light either generated from the active region or capture additional light from an external source, increasing the efficiency of the device (Foust Paragraphs 0005-0008 and 0035). Furthermore, Foust teaches the use of phosphor particles in the device to convert sunlight wavelengths to wavelength which are more readily adsorbed by the organic active layers as well as to enhance light trapping (Foust Paragraph 0022). Foust does not teach additional alternative methods for enhancing the efficiency of the device.

Forrest teaches depositing a gold layer as an electron-hole recombination site over a second organic layer, such as PTCBI (Forrest Paragraphs 0062-0065; Fig. 1 and 2). This deposition is followed by a third and fourth layer between over the gold recombination zone and an electrode over the entire structure (Forrest Paragraphs 0023, 0062-0065; Fig. 1 and 2).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to add a gold electron-hole recombination layer and a third and fourth organic semiconductor layer over the second organic semiconductor as taught by Forrest to the methods taught by Foust. One would have been motivated to do so to increase the efficiency of the photovoltaic device by boosting photo voltage (Forrest Paragraphs 0023-0024 & 0063; Fig. 3).

19. Claims 20 and 21 are rejected under 35 U.S.C. 103(a) as being unpatentable over Foust ('508) in view of Forrest ('462).

Foust teaches the method of claim 17 wherein one layer of an organic region is an electron acceptor and another layer is an electron donor and that electron-hole pairs created by absorption of photons must be dissociated to generate a current (Foust Paragraph 0007). Foust is silent, however, regarding specifically describing methods to increase the dissociation of charges.

Forrest teaches methods for forming organic photovoltaic devices having an electron acceptor layer and electron donor layer wherein charge dissociation efficiency is related to active layer thickness and interfacial geometry (Forrest Paragraph 0020). Forrest further teaches that nanotextured materials having repeated interfaces or highly folded interfaces can offer improvement of charge collection (Forrest Paragraph 0022). The exciton diffusion length should be greater than the layer thickness, or protrusion diameter, to avoid electron-hole recombination (Forrest Paragraph 0020). The thickness should not be so large as to reduce the strength of dissociation-assisting electric fields, leaving an optimum range for the thickness, or protrusion diameter (Forrest Paragraph 0020).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to set the diameter of protrusions to be 1.5 to 3 times the exciton diffusion length to optimize the charge carrier dissociation efficiency by controlling the surface interface as described above. It has been held that where the general conditions of a claim are disclosed in prior art, discovering the optimum or working ranges involves only routine skill in the art. *In re Aller*, 105 USPQ 233.

20. Claim 6 is rejected under 35 U.S.C. 103(a) as being unpatentable over Saurer (`570) in view of Forrest (`102).

Saurer teaches the method of claim 1 wherein organic semiconductor molecules can be deposited by an organic vapor phase deposition method, but does not teach specific conventional details such as the substrate temperature and chamber pressure.

Forrest teaches an organic vapor phase deposition method for depositing organic semiconductor molecules into layers. It would have been obvious to one of ordinary skill in the art at the time the invention was made to deposit the organic layers of Foust by using a substrate temperature of 15 degrees Celsius and a pressure of 0.65 Torr as taught by Forrest in order to maintain surface integrity and quality of the layers (Forrest Col. 8, Lines 5-51). Furthermore, Foust teaches that it is desirable to maintain low processing temperatures during construction of the organic devices to maintain the integrity of the organic layers (Foust Paragraph 0038). It has been held that discovering an optimum value of a result effective variable involves only routine skill in the art. *In re Boesch*, 617 F.2d 272, 205 USPQ 215 (CCPA 1980).

21. Claim 7 is rejected under 35 U.S.C. 103(a) as being unpatentable over Saurer (`570) in view of Forrest (`102) as applied to claim 6 above, and further in view of Forest (`846).

Saurer in view of Forrest (`102) teaches the method of claim 6 where the first electrode is ITO (Saurer Col. 3, Line 34), the first organic layer is CuPc (Saurer Col. 6, Line 51) and the second organic electron accepting layer can be, for example, perylenes (Saurer Col. 6, Line 43). However, Saurer does not teach using the specific compound 3,4,9,10-perylenetetracarboxylic bis-benzimidazole (PTCBI) as an electron acceptor layer, the second organic layer.

Forrest (`846) teaches forming layers of CuPc and either perylene or PTCBI as an electron donor and electron acceptor layer, respectively (Paragraphs 0034, 0044-0045 and 0062-0065). It would have been obvious to one of ordinary skill in the art at the time the invention was made to use PTCBI in place of perylene for an electron acceptor layer since the compounds are functional equivalents (Forrest Para. 0044). It has been held to be within the general skill of a worker in the art to select a known material on the basis of its suitability for the intended use as a matter of obvious design choice. The selection of a known material based on its suitability for its intended use supported a prima facie obviousness determination in *Sinclair & Carroll Co. v. Interchemical Corp.*, 325 U.S. 327, 65 USPQ 297 (1945) See also *In re Leshin*, 227 F.2d 197, 125 USPQ 416 (CCPA 1960). MPEP § 2144.07.

22. Claim 8 is rejected under 35 U.S.C. 103(a) as being unpatentable over Saurer (`570) in view of Forrest (`102) as applied to claim 6 above, and further in view of Yoshino (IEEE).

Saurer in view of Forrest teaches that the first electrode can be ITO (Saurer Col. 3, Line 34) and that the first layer electron donor can be CuPc (Saurer Col. 6, Line 51, for example), but does not teach that the second layer electron acceptor can be C60.

Yoshino teaches that C60 can be an electron acceptor (Page 1315, Right Col.). It would have been obvious to one of ordinary skill in the art at the time the invention was made to use C60 as the electron acceptor second layer of Saurer in view of Forrest since Yoshino teaches that C60 has good acceptor properties and it enhances photoconductivity in a junction with polymers (Page 1315, Right Col.). It has been held that the selection of a known material based on its suitability for its intended use supported a prima facie obviousness determination in *Sinclair &*

Carroll Co. v. Interchemical Corp., 325 U.S. 327, 65 USPQ 297 (1945) See also *In re Leshin*, 227 F.2d 197, 125 USPQ 416 (CCPA 1960). MPEP § 2144.07.

23. Claim 23 is rejected under 35 U.S.C. 103(a) as being unpatentable over Saurer ('570) in view of Yoshino (IEEE).

Saurer teaches that the first electrode can be ITO (Col. 3, Line 34) and that the first layer electron donor can be CuPc (Col. 6, Line 51, for example), but does not teach that the second layer electron acceptor can be C60.

Yoshino teaches that C60 can be an electron acceptor (Page 1315, Right Col.). It would have been obvious to one of ordinary skill in the art at the time the invention was made to use C60 as the electron acceptor second layer of Saurer since Yoshino teaches that C60 has good acceptor properties and it enhances photoconductivity in a junction with polymers (Page 1315, Right Col.). It has been held that the selection of a known material based on its suitability for its intended use supported a prima facie obviousness determination in *Sinclair & Carroll Co. v. Interchemical Corp.*, 325 U.S. 327, 65 USPQ 297 (1945) See also *In re Leshin*, 227 F.2d 197, 125 USPQ 416 (CCPA 1960). MPEP § 2144.07.

Response to Arguments

24. The Examiner notes that the reference of Han ('665) which was relied upon in the Office Action dated 8 January 2007 was not provided to the Applicant. As such, the present Office Action has provided the reference. Furthermore, the Applicant's arguments concerning the reference of Han ('605) are not commensurate with the rejection of the present Office Action,

under the reference of Han (`655), and are therefore moot. The Applicant argues on Page 9 of the Remarks submitted 11 May 2007 that a dye sensitized solar cell is different from the Applicant's invention. In response, the Examiner notes the manner in which the claim is written does not distinguish the method from the prior art as shown in the Office Action.

25. Applicant's arguments filed 11 May 2007 have been fully considered but they are not persuasive. The Applicant's argue that the prior art does not teach a "bulk heterojunction". However, the Examiner notes that the manner in which the claim is written does not limit the degree to which protrusions or interpenetration occurs at the interface between the first layer and the second layer. Both the claims as written and the specification fail to define a "bulk heterojunction" in a definite manner which distinguishes over the prior art as applied. Therefore, *any two layers*, meet the claim since all layers have at least some protrusions or interpenetration, even if it occurs only at the atomic scale.

26. The Applicant's argue that since Forrest (`102), Forrest (`846) and Forrest (`462) do not teach a bulk heterojunction and therefore cannot be combined with other references. In response, the Examiner notes that both the claims as written and the specification fail to define a "bulk heterojunction" in a definite manner which distinguishes over the prior art as applied. Therefore, *any two layers*, meet the claim since all layers have at least some protrusions or interpenetration, even if it occurs only at the atomic scale.

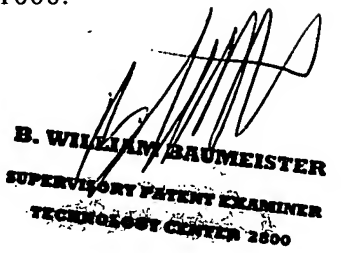
Contact Information

27. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Matthew W. Such whose telephone number is (571) 272-8895. The examiner can normally be reached on Monday - Friday 9AM-5PM EST.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Bradley W. Baumeister can be reached on (571) 272-1722. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

Matthew W. Such
Examiner
Art Unit 2891



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